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Economic Appraisal of a Community-Wide Cardiovascular Health Awareness Program

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ABSTRACT

Background: Cardiovascular disease (CVD) is a leading cause of hospitalizations, death, and health care costs. Although studies have shown that modifying CVD risk factors at the patient level improves patient prognosis, the effect of community-wide interventions at the population level has been uncertain. **Objective:** To evaluate the resource use and cost consequences of a community-wide Cardiovascular Health Awareness Program (CHAP). **Methods:** Thirty-nine medium-sized communities in Ontario, Canada, participated in a community cluster randomized controlled trial stratified by population size and geographic location. All community-dwelling elderly residents (>65 years) in each community were included. Family physicians, pharmacists, community nurses, local organizations, and volunteers in the intervention communities implemented the program. Rates and costs of CVD hospitalizations, all hospitalizations, emergency department visits, physician visits, and prescription medication use in the year before and after the intervention were compared for the 19 control and 20 CHAP communities by using province-wide linked administrative databases. The cost of implementing and administrating CHAP in each community was combined with total community health care cost to determine the net cost effect. **Results:** CHAP was associated with a reduction in CVD hospitalization costs. There were no differences in utilization rates or costs for overall hospitalizations, in visits to emergency rooms, physicians, or specialists, or in the use of prescription medications. Results were robust over a range of cost assumptions. **Conclusions:** A community-wide CVD awareness program can be implemented and can reduce CVD-related hospitalization costs at the level of the community without a corresponding increase in overall health care costs.
Keywords: Cardiovascular, Cluster randomized controlled trial, Community-wide intervention, Cost analysi, Cost consequence analysis, Economic evaluation.

Introduction

Heart disease and stroke are among the most common, costly, and preventable conditions responsible for significant disability, death, and cost to health care systems and society. Approximately 5% of the Canadian population has heart disease [1–3], and together with stroke, cardiovascular disease (CVD) is responsible for 30% of Canadian deaths [4,5], 3 million or 17% of all hospitalizations [1–3], and more than $20 billion in costs each year [1,6,7]. Although the overall rate of hospitalizations for CVD has been decreasing over the past two decades [3], the actual number of hospitalizations and deaths is projected to increase in the future because of the aging population and an increase in the prevalence of CVD risk factors among children and young adults. This confluence of factors was described in a recent report by the Heart and Stroke Foundation of Canada as "A Perfect Storm" that will continue to increase the burden of CVD [8].

Among Canadians who do not already have overt CVD, many run a high risk of developing it. Approximately 80% of the population has at least one modifiable risk factor for CVD, and 10% have three or more risk factors [5]. Among the traditional CVD risk factors (i.e., smoking, physical inactivity, obesity, high blood pressure, and diabetes), the prevalence of high blood pressure rose from 11.6% to 14.4% over the past few years alone,

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and among the elderly population, 53.2% have high blood pressure whereas only 66% have it treated and under control [9]. The underdetection and undertreatment of hypertension and other risk factors for CVD leads to large social and economic burdens in terms of hospitalizations, other health care utilization, excess mortality, and potential years of life lost [10]. Therefore, decreasing these risk factors at the population level can have a large effect on reducing the burden of CVD.

CVD is largely preventable and manageable through lifestyle interventions and pharmacological therapies [11]. In 2003, however, the Heart and Stroke Foundation of Canada reported that up to 60% of the Canadians were "seriously misinformed" with respect to their knowledge of the risk factors and warning symptoms of heart disease and stroke. It was recommended that patient health literacy strategies should emphasize awareness of risk factors, especially hypertension, and the focus should be on primary and secondary prevention [12]. A number of mass media campaigns have targeted increased awareness about these modifiable risk factors and how they can be better identified and managed. In addition, there has been a greater emphasis on encouraging family physicians to spend more time with their patients to identify and appropriately treat these risk factors. Although there have been noticeable advances in the identification and treatment of CVD using these approaches, there remain significant barriers in terms of patient denial, underdiagnosis, misdiagnosis due to multiple health conditions, suboptimal treatment, and patient nonadherence to lifestyle modifications or recommended treatment. There is a clear need for innovative approaches to help identify and emphasize the importance of preventing and appropriately treating CVD risk factors.

An alternative approach to individual patient intervention is to manage patients through community-wide CVD prevention and surveillance programs. An example of such a program is the Chronic Care Model described by Wagner et al [13], which has elements of improved clinical information, decision support, delivery systems, self-management support, and community/organizational leadership. Community empowerment, including participation and linking with other people and organizations, can lead to improvement in health outcomes of community residents [14]. In a recent systematic review, Pennant et al. [15] identified 36 controlled and observational studies of community programs for the prevention of CVD. A large number of these studies reported a positive trend in CVD risk score, but only a few reported positive changes in CVD/mortality rates, and in all but one, the change was nonsignificant. These negative results could possibly be due to biases that arise because these studies were not randomized controlled trials (RCTs). Negative results could also be due to the nature of the interventions evaluated, because small-scale or short time-line interventions may not result in a significant and sustained effect for a community as a whole. Given that these programs have failed to show benefits on major health outcomes [15], it is not surprising that no economic evaluations of community-wide CVD interventions have been conducted.

Presented here is an economic evaluation of a recently reported trial [11] assessing the effectiveness of a community-wide Cardiovascular Health Awareness Program (CHAP) [10,11,16–18]. Established 10 years ago, CHAP was designed to improve cardiovascular health at a population level using a community-level intervention aimed at shifting the population CVD risk profile. CHAP was developed and refined through several pilot studies, scientific trials, and community-wide demonstration projects in Ontario and Alberta, Canada, and then was expanded and rigorously evaluated in a large multicommunity trial. The specific objective of this study was to compare the resource use and cost consequences in communities with a structured community-wide CHAP versus communities without such a program (i.e., usual care).

Methods

Overview of the CHAP Community Trial Study Design

A detailed description of the CHAP intervention, community-wide study design, and outcomes was reported elsewhere [10,16–18]. In brief, a cluster RCT was conducted in 39 cities/towns across Ontario, with populations between 10,000 and 60,000 inhabitants and these communities stratified by geographic location and population size of residents 65 years and older. Communities within each stratum were randomly allocated to either the intervention ($n = 20$) arm or the control ($n = 19$) arm of the study. The total population of the study communities at the start of the intervention period was 973,246, with 140,642 community-dwelling residents 65 years and older. Residents who resided in long-term care facilities were excluded from the trial, because they had no opportunity to participate in CHAP sessions [10]. Although residents in long-term care facilities could benefit from community-wide informational sessions and other interventions such as those offered through CHAP, our pilot work revealed that participation in CHAP for residents in long-term care facilities would be problematic and therefore the effect of CHAP would be minimal for these residents. For this reason, our study targeted community-dwelling elderly residents only.

Interventions Compared

In both study communities, residents received the usual health promotion and health care services available to all residents under Ontario's publicly financed universal health insurance system [11]. Information on other health promotion activities during the study period was collected at the beginning, during, and at the end of the study.

In addition to usual health promotion and health care services, the elderly residents in the intervention communities were exposed to CHAP. CHAP is a multipronged prevention program that mobilized and coordinated health professionals and community-based organizations to better identify and manage heart disease and stroke risk factors. Through a number of different strategies designed to reach out to residents during the autumn of 2006 [10,11,16,18], elderly residents in the intervention communities were invited to attend blood pressure and CVD risk-factor assessment and education sessions held during a 10-week period operated by trained volunteers in local pharmacies concurrently in all 20 intervention communities. With participants' consent, summary CVD risk profile reports were sent to their family physician and regular pharmacist. In addition, each participant received a copy of the report, along with cardiovascular health education materials and a list of local resources supporting lifestyle changes. Participants were referred to community health nurses and pharmacists as needed for follow-up and drug-related consultations. At the end of the 10-week program, all session results were forwarded to family physicians in the form of reports that rank ordered their patients by systolic blood pressure and diagnostic/treatment status. Six months later, aggregate-level comparative feedback, along with individual patient data, was sent to family physicians, again showing blood pressure control of patients from their practice who participated in CHAP compared with patients of other family physicians in their own community and across all 20 intervention communities [10,11].

Primary and Secondary Outcomes of the Overall Study

The primary outcome measure of the overall study was the mean annual number of hospital admissions for acute myocardial infarction (MI), congestive heart failure (CHF), and stroke among trial elderly residents in intervention and control communities. Secondary outcome measures included mortality among patients hospitalized for CVD and coronary artery disease, all-cause mortality, hospitalizations for stroke and coronary artery disease, and initiation of antihypertensive drug therapy [10,11]. The assessment of CHAP outcomes was based on the retrospective analysis of routinely collected, population-based administrative health data and was focused on the relative change in the mean primary and secondary outcome event rates at the community level in the year before (September 1, 2005, to August 31, 2006: "preintervention") compared with the year after (September 1, 2007, to August 31, 2008: "postintervention") the implementation of CHAP. Health data collected for the preintervention period were used to compute baseline outcome event rates at the community level, which enabled adjustment for any imbalances at baseline not accounted for through community randomization [10]. Because this was an assessment at the level of the entire community longitudinally over a year and at two time periods (i.e., pre- and postintervention), the number of patients in each community was different at the beginning and at the end of each time period and during each time period due to mortality, migration in and out of communities, and aging of residents in the community. Therefore, although mean rates of hospitalization and other health care use were calculated on the basis of the number of elderly residents in the communities, the rates over time were not based on the same elderly residents in the communities at each time point. Because of this, CHAP was designed and approved by research ethics boards to be conducted at the level of community using aggregated community data. Individual patient consent, required for linking of patient administrative data, was not obtained for this study, and only aggregated data were used in the analysis.

Economic Appraisal—Resource Use and Cost Consequences

The economic appraisal comprised two components: a comparison of health care resource use across the intervention and control communities and a comparison of the cost consequences of health care resource use across the intervention and control communities.

For the health care utilization analysis, the rates of health care resource utilization over the preintervention and the postintervention periods were obtained for senior residents in both intervention and control communities by using linked administrative health data housed at the Institute for Clinical and Evaluative Sciences [19]. Residents 65 years and older in each community were identified through birth dates and place of residence (i.e., community or long-term care facility), and then the unique patient identifier for community-dwelling residents was used to obtain all health care resource use over the 1-year follow-up period for the entire cohort of patients. Community-wide information on hospitalizations, hospital emergency department visits, family physician visits, specialist physician visits, and prescription drug use for all community-dwelling elderly residents in each community were compared for the pre- and postintervention periods. Rates of use for each health care category (e.g., hospitalizations and prescription drug claims) were computed by dividing total community use by the number of community-dwelling residents in the community. These rates were compared across control and intervention communities in the postintervention period after controlling for resource use in the preintervention period (see the Statistical Analyses subsection). The number of elderly residents in the communities was different across the time periods owing to mortality, migration in and out of the communities, and aging of the population in the communities over time. As such, the economic analysis was conducted at the level of the community and not at the level of individual patients. Data sources included the hospital discharge abstract database of the Canadian Institute for Health Information [20], the physician service claim database of the Ontario Health Insurance Plan [21], and the prescription drug claim database of the Ontario Drug Benefit Program [22].

The cost consequence analysis comprised two components: the incremental cost of CHAP for each intervention community and the health care cost of hospitalizations, emergency department visits, family doctor and specialist visits, and prescription drug claims for all community-dwelling seniors in each community for the year after the intervention period. In terms of CHAP intervention costs, considerable administration, organizational, and logistical issues needed to be completed before CHAP could be implemented in each community. As such, CHAP preimplementation and actual implementation occurred over a 20-month period from January 2006 to August 2007. Costs incurred during this time period included development and planning costs, hiring and training costs, setup costs, and costs of implementing CHAP. The total cost of CHAP implementation directly attributable to each of the intervention communities was based on recorded expenditures for staff salaries, program advertising, equipment (e.g., blood pressure devices, pagers, and cell phones), materials (e.g., tables and chairs), travel, meetings, and office supplies. Because of considerable variability in, and inherent difficulties in, estimating specific information around administration resources provided "in kind" by intervention communities, "in-kind" resources were not included in the base-case cost analysis and various scenarios were considered in sensitivity analyses. In addition to pre- and implementation costs directly incurred by each community, there were significant CHAP costs incurred by two regional CHAP coordinators and by the central CHAP team administration [11]. The cost of centralized CHAP services included data management services (Clinforma) [23], the cost of personnel, operating costs, and the cost of transportation, equipment, materials, and supplies. The allocation of CHAP central costs to each intervention community was based on the proportion of eligible residents in each community. Alternative allocation bases for CHAP central costs were tested in sensitivity analyses.

Costing for health care resource utilization at the community level (i.e., hospitalizations, emergency department visits, family physician and specialist physician visits, and prescription drug claims) for community-dwelling seniors for the year after the intervention period was based on resources reported in the province-wide linked administrative databases multiplied by unit costs of each resource consumed. Unit prices/costs were obtained from various sources. The cost of hospitalizations was based on the case-mix group for each admission multiplied by the corresponding resource intensity weight for the admitting hospital and the case-mix group [24]. The cost of emergency department visits was based on average costs from the Ontario Case Costing Initiative [25], and the cost of prescription drugs was the amount paid by the provincial government (including applicable dispensing fees) recorded in the Ontario Drug Benefit Database [22]. Finally, physician service payments were obtained from the Claims History Database of the Ontario Health Insurance Plan [21]. A sample of unit costs is presented in Table 1.

All costs are expressed in 2010 Canadian dollars, and because of the short time horizon of the cost analysis (i.e., 1 year), discounting of costs in future years was not required. The perspective of the cost analysis was from the Ontario Ministry of Health and Long-Term Care.

Sensitivity Analyses

To test the robustness of the analysis to alternative costing assumptions, a number of sensitivity analyses were conducted.

Table 1 – Selected unit costs assigned for costing the administrative databases (in 2010 Canadian dollars).

Resource item	Unit cost (2010 CAN$)	Source
Hospital admission (average cost for typical case minus physician services)		
CMG 194: Myocardial infarction (without cardiac catheter)	7656.00	CIHI
CMG 196: Heart failure (without cardiac catheter)	6633.00	CIHI
CMG 028: Unspecified stroke	6947.00	CIHI
Visits to hospital emergency departments (average cost minus physician services)	252.94	OMOHLTC
Family physician consultation	62.65	OHIP SOB
Specialist (internal medicine) consultation	143.40	OHIP SOB
Common prescription medications (drug benefit price)		
Ramipril, 10 mg capsule, generic	0.48	ODB Formulary
Quinapril, 40 mg tablet, brand	0.85	ODB Formulary
Hydrochlorothiazide, 50 mg tablet, generic	0.05	ODB Formulary

CIHI, Canadian Institute for Health Information; CMG, case-mix group; ODB, Ontario Drug Benefit Plan; OHIP SOB, Ontario Health Insurance Plan Schedule of Benefits; OMOHLTC, Ontario Ministry of Health and Long-Term Care.

In addition to considering all hospitalizations, an analysis based on the composite of admissions associated with a most responsible diagnosis of acute MI, CHF, or stroke (i.e., the CHAP primary outcome measure) was conducted. We also explored alternative assumptions regarding the allocation of CHAP central administration costs to intervention communities. We examined two scenarios: no central administration costs allocated to intervention communities and an equal allocation to each community (i.e., total CHAP central administration cost divided by 20). Intervention communities provided "in-kind" administration resources (e.g., volunteer time, office space, equipment, and furniture). Because these resources were inconsistently documented by the participating communities, however, we assessed the effect of incorporating a series of fixed "in-kind" contributions ($5,000, $10,000, and $15,000, respectively) from each intervention community. Finally, given that there was a recent change in generic drug pricing in the province of Ontario that resulted in a significant decrease in the cost of generic drug prices, which would not be reflected in the drug prices observed during our study period, we examined the effect of reducing drug prices across the board by 25%.

Statistical Analyses

For the analysis of community health resource utilization rates and costs, we used ordinary least squares (OLS) regression models for each resource use category (e.g., hospitalizations, physician visits, and prescription drugs) and for each cost category (e.g., hospital costs, physician visit costs, and prescription medication costs). Because data were obtained for the level of the community and the number of patients in each community was different over time due to mortality, migration in and out of the communities, and aging of residents in the communities, the unit of analysis was the community. The dependent variable was the postintervention count (i.e., number of counts in each resource use category or cost in each subcategory), and we regressed this on the intervention indicator variable (i.e., one for intervention and zero for control communities) and the preintervention count. The mean difference in utilization rates (intervention vs. control) was calculated for the resource use analyses and the mean difference in costs for the cost analyses. OLS assumptions were tested with the following two methods: First, the studentized and jackknife residuals were plotted in a univariate fashion and the distribution was normality tested by using the Shapiro-Wilk test. Second, homoscedasticity was graphically evaluated by plotting the residuals against the predicted values of the dependent variable. SAS version 9.1.12 was used for all analyses (SAS Institute, Cary, NC).

Results

Primary Findings from the Overall Study

As previously reported, the control and intervention communities were well balanced and CHAP was successfully implemented in all 20 randomly selected communities [10,16,17]. The main clinical finding was a statistically significant and clinically important 9% relative reduction in the rate of hospital admissions for acute MI, CHF, and stroke for the entire population of residents 65 years and older during the year after the implementation of CHAP, compared with control communities [11].

Economic Appraisal—Resource Use and Cost Consequences

The results comparing the rates of CHAP resource utilization in the intervention versus control communities by resource use category are listed in Table 2. As shown in Table 2, CHAP was associated with a lower absolute rate of hospitalizations for the composite outcome of acute MI, CHF, and stroke (−2.90 mean hospitalizations per 1000 people; 95% confidence interval [CI] −5.98 to 0.18; $P = 0.064$). The rate of hospital admission was the same for both groups in the postintervention period (i.e., 243 per 1000), and even after adjusting for baseline imbalances, the difference in the mean rate of total hospitalizations was similar for both communities (−8.46; 95% CI −19.79 to 2.94; $P = 0.141$). Similarly, the difference in the mean rate of hospital emergency department visits (4.71; 95% CI −37.93 to 47.35; $P = 0.824$), family physician visits (−95.37; 95% CI −353.80 to 163.06; $P = 0.824$), specialist visits (15.10; 95% CI −120.25 to 150.45; $P = 0.822$), and prescription medication use (263.07; 95% CI −215.36 to 741.50; $P = 0.272$) was similar in both communities.

Community-based CHAP intervention costs ranged from as low as $11,976 to as high as $57,113, depending on the community size, internal volunteer support, and the availability of "in-kind" infrastructure support. Across all intervention communities, the total community-based cost was $609,874 or an average of $30,494 per community. In addition, CHAP central costs amounted to $804,304 or an average of $40,215 per

Table 2 – Comparison of utilization rates (mean per 1000 patients) for selected resources, by study arm and study time period.

Resource item	Preintervention period (September 1, 2005, to August 21, 2006)		Postintervention period (September 1, 2007, to August 31, 2008)		CHAP minus control utilization difference*,† (95% CI); P value
	CHAP (n = 67,874)	Control (n = 72,768)	CHAP (n = 69,942)	Control (n = 75,499)	
CHAP hospitalizations‡	30	29	28	30	−2.90 (−5.98, 0.18); 0.064
All hospitalizations	265	254	243	243	−8.46 (−19.79, 2.94); 0.141
Visits to hospital emergency departments	778	754	804	774	4.71 (−37.93, 47.35); 0.824
Family physician claims	6058	6421	5496	5894	−95.37 (−353.80, 163.06); 0.459
Specialist claims	2820	2901	2865	2918	15.10 (−120.25, 150.45); 0.822
Prescription drug claims	6385	6454	7621	7438	263.07 (−215.36, 741.50); 0.272

CHAP, Cardiovascular Health Awareness Program; OHIP, Ontario Health Insurance Plan.
* Postintervention period rates adjusted for preintervention rates.
† All regression models satisfied ordinary least squares assumption testing ($P < 0.01$), with the exception of specialist visits and the number of prescription drug claims.
‡ Composite of admissions associated with a most responsible diagnosis of acute myocardial infarction, congestive heart failure, or stroke.

Table 3 – Comparison of mean annual health care and interventions costs per resident, by study arm and study time period (in 2010 Canadian dollars).

Resource item	Preintervention period (September 1, 2005, to August 21, 2006)		Postintervention period (September 1, 2007, to August 31, 2008)		CHAP minus control cost difference* (95% CI); P value
	CHAP (n = 67,874)	Control (n = 72,768)	CHAP† (n = 69,942)	Control (n = 75,499)	
CHAP hospitalizations only†	282	269	269	303	−39.72 (−77.80, −1.64); 0.041
All hospitalizations	2164	2110	2160	2129	−18.67 (−157.09, 119.76); 0.786
Visits to hospital emergency departments	259	255	265	265	−4.27 (−16.10, 7.57); 0.470
Family physician visits	191	200	174	184	−1.93 (−10.16, 6.31); 0.638
Specialist visits	137	141	141	143	1.45 (−3.62, 6.51); 0.566
Prescription drug claims	1382	1422	1437	1474	0.42 (−30.87, 31.70); 0.979
Intervention costs	—	—	20.20‡	—	20.20§; n/a
Total health care and intervention costs	4132	4128	4198	4196	−1.69 (−155.76, 152.39); 0.982

CHAP, Cardiovascular Health Awareness Program; CI, confidence interval; n/a, not applicable/available.
* Postintervention period costs adjusted for preintervention costs.
† Composite of admissions associated with a most responsible diagnosis of acute myocardial infarction, congestive heart failure, or stroke.
‡ Intervention costs (for base case): $1,414,178/69,942 or $20.20 per senior resident.
§ Average intervention cost of $20.20 per resident applied to all residents in intervention communities; therefore, no variability for confidence intervals.

community for the 1-year time period. The total community-based CHAP intervention and CHAP central cost was $1,414,178 (excluding in-kind contributions). This equated to approximately $71,000 per community or $20.20 per elderly resident.

As shown in Table 3, the average health care cost per elderly resident in the year before the intervention was approximately $4100, with 50% of this total due to hospitalizations, 15% due to emergency department and doctor visits, and 35% due to medication drug use. The additional cost of the CHAP intervention (i.e., $20.20 per resident) was offset by slightly lower health care costs in the intervention communities such that the total cost in the year after the intervention was equal in both groups at approximately $4200 per elderly resident (mean cost difference –$1.69; 95% CI –$156.76 to $152.39; $P = 0.982$). The distribution of total costs by resource use category remained the same in the pre- and postintervention periods. With the exception of hospital costs for the composite outcome of acute MI, CHF, and stroke (mean cost difference –$39.72; 95% CI –$77.80 to –$1.64; $P = 0.041$), the difference in costs was not statistically significantly different for total hospitalizations or any of the other cost subcategories.

All 14 regression models held to the OLS assumptions except two: utilization of specialists and the number of prescription drug claims. Residuals for these two outcomes were not normally distributed ($P < 0.01$).

Sensitivity Analyses

Given in Table 4 are the sensitivity analyses under different costing assumptions: 1) which hospitalization costs to include

Table 4 – Sensitivity analyses on key cost assumptions (in 2010 Canadian dollars).

Cost variable	Base case assumption	Assumption(s) for sensitivity analysis	Cost difference* (95% CI); P value
Hospitalization included in cost analysis	All hospitalizations	CHAP hospitalizations†	−29.15 (−81.49, 23.18); 0.266
CHAP central costs	Included in analysis	Excluded from analysis	−13.18 (−167.24, 140.87); 0.863
Allocation basis of fixed CHAP central costs to intervention communities	Proportion of eligible residents in each community	Equal allocation to all 20 communities	1.64 (−152.15, 155.43); 0.983
Administration resources provided "in kind" by intervention communities	Not included	(1) $5,000 to each community	0.16 (−153.88, 154.20); 0.998
		(2) $10,000 to each community	2.00 (−152.00, 156.00); 0.979
		(3) $15,000 to each community	3.84 (−150.13, 157.81); 0.960
Prescription drug costs	As incurred during observation periods	25% reduction in drug costs	−1.70 (−153.31, 149.92); 0.982

CHAP, Cardiovascular Health Awareness Program.
* Postintervention period costs adjusted for preintervention costs.
† Composite of admissions associated with a most responsible diagnosis of acute myocardial infarction, congestive heart failure, or stroke.

in the analysis, 2) the inclusion and allocation of CHAP central costs, 3) assumptions regarding the estimated value of in-kind contributions from the intervention communities, and 4) results assuming a general lowering of prescription medication costs in the province as occurred in the year after the completion of the study. These results show that the overall cost findings are somewhat sensitive to whether the total health care cost estimate incorporates the subset of hospitalizations included in the primary outcome measure (acute MI, CHF, and stroke; −$29.15 [−$81.49, $23.18]; P = 0.266) as opposed to all hospitalizations. The inclusion or allocation of CHAP central costs, the estimate of in-kind contribution, and the use of lower drug costs, however, did not have a substantial effect on the cost differences.

Discussion

As CVD is largely preventable and manageable through lifestyle modifications and pharmacological therapies, programs aimed at identifying and modifying patient risk factors can have a substantial effect on patient outcomes and costs to the health care system. Nevertheless, a significant proportion of patients lack knowledge about CVD risk factors in general and more specifically about the early warning signs of CVD. In addition, a number of patients are underdiagnosed for CVD and misdiagnosed owing to having multiple chronic diseases and physicians are often reluctant to initiate aggressive pharmacological treatments. As a result, individual patient, clinician, clinic, and community barriers exist for initiatives aimed at CVD prevention and management. Physician-based programs such as monitoring of patient risk factors, increased education of patients about CVD risk factors, initiatives targeted toward increased patient compliance with therapy, or changes in lifestyle behavior are resource intensive and as a result have had limited uptake.

Community-wide CVD education and awareness programs such as CHAP have the appeal of potentially reaching a wide audience, and because of physician reluctance to initiate aggressive therapy, limited time spent with patients, misdiagnoses, and patient denial, these programs can potentially be more effective than individual-level strategies. This evaluation demonstrated that a CHAP-like community-wide CVD awareness program can be successfully implemented and can reduce CVD-related hospitalization costs at the level of the community without increasing overall health care costs. Nevertheless, despite the success of CHAP, previous community-wide CVD programs have produced mixed results. Controlled and observational studies identified by Pennant et al. [15] in a recent systematic review were limited to assessing changes in CVD risk scores and not actual CVD events or hospitalization rates. Across all studies, the net reduction in 10-year CVD risk was 9.08%, which is similar to the 9% relative risk reduction of CVD hospitalizations found for CHAP. Only a handful of these community programs examined changes in CVD/mortality rates and most of these reported a positive, but nonsignificant, treatment effect. The difference in the results from CHAP and these previously conducted community-wide CVD programs may be due to study design. For example, non-RCTs can be influenced by confounding factors that can potentially bias the analysis. Similarly, interventions done on a small-scale/scope or for a short period of time may not be sufficient to result in a significant and sustained effect for a community as a whole.

There are a number of strengths of our study. First, CHAP is an exemplar program of the Chronic Care Model [13] as it comprises all the models' essential elements including improved clinical information systems, decision support, improved delivery system design, self-management support, and community and organizational leadership. Although the findings from this study apply specifically to CHAP in the communities evaluated, we believe that the intervention components of CHAP can be implemented elsewhere and therefore the intervention is generalizable to other communities and health care settings. It is uncertain, however, what outcomes would be achieved after the implementation of CHAP in other jurisdictions. Second, we showed that CHAP can be successfully implemented in a large number of randomly selected communities (i.e., 20) and in so doing can mobilize a significant amount of community support and enthusiasm from existing community resources and health care workers in each community. Third, we have developed a far-reaching community-wide intervention that, despite its complexity and overall reach, has a relatively low cost of implementation. Fourth, the cluster RCT design of this study meant that baseline utilization rates and costs as potential confounding factors were controlled for in the study. This has been a major limitation of previous community-wide evaluations. Although a patient-level analysis with covariate adjustments would have been an even stronger adjustment [26,27], this analysis was not possible for CHAP. And finally, a major strength of this study is the large-scale scope of the intervention implemented and the relatively long duration of the intervention. With the combination of these strengths, this study was able to show a reduction in CVD-related hospitalization costs.

Despite these strengths, the study had limitations. One is that CHAP is a bundled intervention with many components of the bundled intervention. As such, it is not possible to determine the independent contribution of each component of the bundled intervention. Another limitation is that these results apply to medium-sized rural communities and it is uncertain whether CHAP would be as successful in urban settings or with diverse populations. Third, although individual patient-level analysis would have some advantages compared with cluster community analyses [26,27], the individual patient-level analysis was not possible for CHAP because of the large scope of the study (i.e., more than 140,000 elderly residents) and the fact that the individual patient-level consent required to access and analyze linked patient administrative health records was not feasible or approved for the study. And finally, CHAP was successful in mobilizing significant community support for the intervention communities and for the most part this volunteer assistance and the in-kind contributions from the local lead organizations within the CHAP communities have not been accounted for in the analysis of implementation costs. Our sensitivity analysis adding in various hypothetical in-kind contributions suggests that a better accounting and analysis of these costs would likely not result in higher overall health care and implementation costs.

Conclusions

This evaluation demonstrated that this specific community-wide CVD awareness program can be successfully implemented and can reduce CVD-related hospitalization costs even at the level of the community. Despite being associated with implementation costs of approximately $71,000 per community or $20.20 per older adult resident, the cost of CHAP was offset by slightly lower health care costs such that overall costs were virtually identical in both the intervention and control communities. The results from the sensitivity analyses confirm the overall conclusion that CHAP can be successfully implemented, can reduce CVD-related hospitalization costs, and will not result in an overall increase in health care costs.

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